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Diet quality, social determinants and weight status in 12-year-old Puerto Rican children

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Abstract

Diet quality may be influenced by social determinants and weight status. This has not been studied in Puerto Rico (PR); therefore, this cross-sectional study examined if diet quality, assessed by the Healthy Eating Index-2005 (HEI-2005), differs by social determinants (gender, school type and region) and weight status in children in PR. As part of an “island-wide” study to evaluate oral health in 1,550 12-year-old children, dietary intake was assessed in a representative subset (n=796) using a 24-hr diet recall. Diet quality was evaluated from the diet recall results using the HEI-2005. Overall mean HEI-2005 score was 40.9, out of a total maximum score of 100. Girls had significantly higher scores for whole fruit, total vegetables, whole grains, and sodium but

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lower scores for total grains and milk compared to boys ($p<0.05$). Children from public schools had higher scores for total fruit, whole fruit, dark-green and orange vegetables and legumes, but lower scores for whole grains and milk compared to those from private schools ($p<0.05$). Children from the Central Mountains had higher scores for the dark-green and orange vegetables and legumes and whole fruit compared to the other regions ($p<0.05$). Overweight children had significantly higher scores for total vegetables and milk but lower scores for total fruit and sodium as compared to non-overweight children ($p<0.01$). In conclusion, some components of diet quality were associated with the social determinants studied and with weight status in this sample. Overall diet quality needs improvement in PR children so that it is better aligned with dietary recommendations.

Keywords

diet quality; Healthy Eating Index-2005; social determinants; childhood obesity; Hispanic

INTRODUCTION

Overweight and obesity are serious public health issues in the United States (US) and in Puerto Rico (PR). During childhood and adolescence, it can lead to serious chronic diseases during adulthood,^{1,2} such as cardiovascular diseases, diabetes, and certain cancers,³⁻⁵ three conditions that are among the primary mortality and morbidity causes in the US and PR.^{6,7}

In PR, data from the Behavioral Risk Factor Surveillance System Survey in 2009 showed that 38% of the adults were overweight and 28% were obese.⁸ In children, an “island-wide” study in second graders from the PR Department of Health found 16% prevalence for overweight and 26% for obesity.⁹ Another study in a mountain region of PR in elementary school children found the highest prevalence of obesity (47%) in those in 5th and 6th grade (aged 10-12 years).¹⁰

Among the social determinants influencing children’s diet are availability and accessibility of foods and parental socioeconomic status.¹¹ Recent evidence indicates an association between neighborhood food environment with diet and obesity in children and adolescents.^{12,13} For example, those living in neighborhoods with greater access to fast foods and convenience stores had lower diet quality, although the findings are inconsistent.¹⁴ Likewise, low socioeconomic status has also been related with poor diet quality.^{15,16} This is important to study in PR, a small, urbanized island with high availability of fast foods, US-based supermarkets and numerous convenience stores, particularly in the San Juan area. In addition, there is a distinctive difference among children attending public and private schools, where most children from low socioeconomic status go to public schools, while children from higher socioeconomic status go to private schools. However, unlike private schools, public schools have the National School Lunch Program (NSLP), which could impact the diet quality in these children. This has not been properly evaluated in PR. Therefore, this study examined if diet quality, assessed by the Healthy Eating Index (HEI-2005)¹⁷, differs by social determinants, such as gender, socioeconomic status and region, and by weight status in 12-year-old children in PR.

METHODS

Study Design and Participants

Data for the present study were drawn from an “island-wide” cross-sectional study in PR designed to examine oral health, dietary practices, and weight status in a sample of 1,550 12-year-old children enrolled in the academic year 2010-2011. A probabilistic random sample of all public and private schools (n=133) from the 11 health administrative regions of PR, covering the entire island was used in the main study, stratified by gender. For this analysis, regions were regrouped into Coast, Metropolitan and Central Mountain. From this sample, a representative and similar subset sample was chosen to complete the 24-h dietary recall, by randomly selecting 50% of the participants within each school (n=800). Parents or guardians signed a written informed consent and children provided written assent. The study was approved by the Institutional Review Board of the Medical Sciences Campus of the University of PR.

Socio-demographic and Anthropometric Measurements

Gender was self-reported. Socio-economic level was obtained indirectly from the type of school attended, which was used as a proxy. In PR, being in public school is indicative of “low or middle socioeconomic status”, while being in private school is indicative of “high socioeconomic status”.¹⁸ This was confirmed in a subset sample (n=122) that completed information on income. Most parents with children in public schools reported a total annual family income of \$0-10,000 (51%) and \$10,000-20,000 (23%); most parents with children in private schools reported an income of >\$40,000 (77%) and \$30,000-40,000 (23%). The overlap was minimal; only 4.6% of those in public schools had an income >\$40,000 and 8.3% had an income of \$30,000-40,000. Trained staff measured children’s weight and height following the NHANES procedures.¹⁹ Body mass index (BMI) was calculated by dividing weight in kilograms by height in meters squared. Participants were categorized into non-overweight (BMI <85th) and overweight (BMI ≥85th) categories, using the Centers for Disease Control and Prevention age- and sex- specific growth charts.^{20,21}

Dietary Assessment

Dietary intake was obtained by trained interviewers using a single 24-hour dietary recall. The interview was performed at school; children were asked to list all foods and beverages consumed for the past 24 hours, starting with the most recent meal. It included intakes from weekdays and weekends (with no significant differences in energy intake between days); parents were not present in the interview. For estimation of portion sizes, a booklet with drawings of actual serving portions and images of serving sizes of commonly eaten foods and beverages was used.²² Energy intake and food group intake was analyzed using the Nutrition Data System for Research (database version 2011, Nutrition Coordinating Center, University of Minnesota). Of the 800 children that completed the recall, 3 participants whose energy intakes were <500 kcal/day were excluded because only one meal was reported and 1 participant whose energy intake were >6,000 kcal/day was excluded because of overestimation (a total of 14 cans of soda were reported).

Diet Quality Assessment

Food group and nutrient intake data obtained from the recall was used to assess diet quality using the US Department of Agriculture's HEI-2005.²³ The HEI is a measure of diet quality that assesses compliance with the 2005 Dietary Guidelines for Americans.²⁴ It has 12 components (total fruit, whole fruit, total vegetables, dark green and orange vegetables and legumes, total grains, whole grains, milk, meat and beans, oil, saturated fat, sodium and calories from solid fats, alcoholic beverages, and added sugars (SoFAAS)) and each one is evaluated with a density approach; that is, food and nutrient intakes and scoring standards are expressed as the amount per 1,000 kcal. This allows the quality of the diet to be assessed independent of an individual's energy requirement, which is very difficult to determine.²⁵

The components related to total fruit, whole fruit, total vegetables, dark green and orange vegetables and legumes, total grains, and whole grains are scored from 0-5 points each. Milk, meat and beans, oil, saturated fat and sodium are scored from 0-10 points each; calories from SoFAAS are scored from 0-20 points. Participants with intake at the suggested level receive the maximum score. The further intakes are from the standards, the lower the score is. The total HEI-2005 score is calculated as the sum of all components scores and the score range is from 0 to 100.

Statistical Analyses

For descriptive statistics, mean and standard errors were computed for continuous variables and frequencies for categorical values. Since only a single 24-hour dietary recall was used, the HEI-2005 component and total scores were estimated using the population ratio method.²⁵ This method is computed by calculating the population's total intake of food groups or nutrients (relevant to the HEI) and the population's total energy intake and taking the ratio of these. The subpopulation HEI-2005 components and total scores were estimated using the Microsoft Excel (2007, Microsoft) spreadsheet created by the Center for Nutrition Policy and Promotion (CNPP). To test for significant differences between HEI-2005 scores by gender, school type, region and weight status, a two-tailed t-test was used using Stata Statistical Software (StataCorp 2011, *version 12*, TX). One-way ANOVA with Bonferroni post hoc test was used, as appropriate, using GraphPad InStat (GraphPad Software, CA). Statistical tests were not performed on component scores in cases where the maximum total point value was assigned and the standard error is not shown. Statistical significance was set at $P < 0.05$.

RESULTS AND DISCUSSION

The total sample consisted of 796 children. Nearly half of the participants (54.5%) were female and most were from public schools (77.9%) (Table 1). Overweight was found in 40.2% of the children (43.1% in boys and 37.8% in girls; 39.5% in public schools and 42.6% in private schools). No significant difference in weight status was seen by gender, school type, and region (data not shown).

Table 2 describes the daily intake of energy and nutrients and number of food group servings. Fruit, vegetables, dairy products and dietary fiber mean intake are lower than

reported in other studies in Puerto Rican children^{26,27} and in Hispanic children living in US.¹⁶ Such differences could be attributed to differences in dietary assessment methods used and/or population studied. However, similar to these studies, we found that consumption of sugary beverages, meats and sodium are high when compared with current dietary recommendations.

Table 3 shows the mean and standard error for HEI-2005 total and component scores by the social determinants studied and weight status. Children's mean scores met the maximum level for meat and beans, and were close to meeting standards for total grains; both food groups are among the most popular staple foods in PR "rice and beans". The lowest component scores for all subgroups were found for whole fruit, vegetables, and whole grains. Low scores in these components are consistent with findings reported in other studies in Hispanic children living in the US.^{28,29} A study in 993 Hispanic children found that low intakes of fruit, vegetables, and fiber decreased diet quality.¹⁶ The reasons for such low scores have been related to the home environment, such as parents' eating habits, feeding styles and socioeconomic status.¹¹ Scores from saturated fat, sodium and calories from SoFAAS were below half of the maximum score, which means higher intake. These nutrients are found in fried foods and fast foods, which are commonly consumed by children in PR.²⁷ Currently, there are more than 15 chains of fast foods in PR, with more than 1,000 establishments in the island, with about 50% in the Metropolitan region. In addition, it is estimated that more than 70% of foods consumed in the island are imported, mostly from the US.³⁰ Therefore, an Americanized diet has replaced the traditional Puerto Rican diet, which traditionally has consisted of rice, beans, starchy tubers, meats, sugar, lard and coffee, but also of some seasonal tropical fruits and vegetables.³¹ A more recent study in a representative sample of children aged 11-18 years (n=633) in PR confirmed this pattern of low intakes of fruit and vegetables and high intakes of sweetened beverages and fried foods using a cross-culturally validated food behavior checklist.²⁷ However, overall diet quality was not assessed.

The present report found gender differences in diet quality, whereas girls had significantly higher scores for whole fruit, total vegetables, whole grains, and sodium but lower scores for total grains and milk compared to boys ($p<0.05$). This is similar to other studies in which girls had highest scores for fruit, vegetables and whole grains.²⁸ Gender differences in diet may be related to weight issues that may arise in pre-adolescents.³² Also, a recent study evaluating nutrient intakes in 321 children from the San Juan Metropolitan area in PR found that girls had apparently higher participation in the NSLP and this in turn was found to be related to a better diet in the girls compared to boys,²⁶ as this program provides meals with all the recommended food groups.

Children from public schools had higher scores for total fruit, whole fruit, and dark-green and orange vegetables and legumes, but lower scores for whole grains and milk compared to children from private schools ($p<0.05$). We speculate that these differences could be related to their socioeconomic status, as parents with low and middle incomes send their children to public schools,¹⁸ which have NSLP availability; this is not available in private schools. This nutritionally balanced meal may be the only meal with all food groups that these children receive, which includes a fruit and a vegetable at every meal; however, it traditionally did

not include whole grains. Children from private schools typically purchase their foods at the school cafeteria, which usually offers burgers, hot dogs, and sandwiches and is limited in fruits and vegetables; or, they bring their lunch boxes from home. Similarly, higher scores have been found for vegetables, but also for milk, meat, and grains in US children participating in the NSLP.³³ The previously mentioned study in PR children found higher intakes of fiber, energy, calcium, potassium and sodium but lower intakes of the other micronutrients in those participating in the NSLP compared to non-participants,²⁶ but diet quality was not assessed. Recently, the NSLP improved its menu standards and is now requiring more whole grains, which may help improve the diet quality in this group; this warrants further research.

Children residing in the rural Central Mountain region had higher scores for the dark-green and orange vegetables and legumes and whole fruit compared with children residing in the other regions ($p<0.05$). However, those in the Metropolitan region had the highest scores for total fruit and whole grains, while those in the Coast had the highest score for total vegetables. Although a US study in 8,000 individuals found that those from rural areas consume less fruit compared to those from urban areas, which was related to accessibility,³⁴ this is not the case in PR. This rural region has plenty of naturally grown tropical fruit and vegetable sources, but is also relatively close to urban supermarkets and other food stores. Therefore, the context of the rural environment in PR favors a higher intake of fruit and vegetables, while it may not be the case in the US.

In the present study, overweight children had significantly higher scores for the total vegetables and milk components compared to non-overweight children ($p<0.01$), while non-overweight children had highest scores for total fruit and sodium. Similarly, the aforementioned studies in Hispanic children and adolescents in the US¹⁶ and Brazil³⁵ did not find differences in diet quality among non- and overweight participants. This might be explained by the fact that obesity is a complex problem that can be affected by a variety of factors, such as diet, physical activity, and other social and physical environmental determinants.^{36,37} Therefore, HEI-2005 may not fully explain obesity because it only captures compliance to guidelines.²⁴

This is the first published study to describe diet quality in a representative sample of children in PR. However, some limitations should be considered in the interpretation of the results. One such limitation was that validity of the recall was not assessed; however, studies show that children aged 11-14 years old are able to accurately estimate food portion size utilizing perception, conceptualization and memory skills³⁸. Among the strengths, was the inclusion of a large representative sample of PR children, stratified by gender, school type and region. In addition, interviewers were trained and assessments were calibrated with standardized methods.

CONCLUSIONS

The present study showed that some components of diet quality were associated with gender, school type and region and also with weight status. Findings may aid in the development of health promotion and nutritional interventions to improve diet quality in this

population. A special emphasis should be given to increasing consumption of fruits, vegetables and whole grains as HEI scores were lowest for these components. Additional research is needed to better understand social and physical environmental influences on diet quality and weight status during childhood and adolescence.

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Table 1

Demographic characteristics of 12-year-old Puerto Rican children enrolled in the academic year 2010-2011 (n=796).

Attribute	n	%
Gender		
Male	362	45.5
Female	434	54.5
School Type		
Private	176	22.1
Public	620	77.9
Region ^a		
Coast	356	44.0
Metropolitan	350	44.7
Central Mountain	90	11.3
Weight Status ^b		
Non-overweight	476	59.8
Overweight/Obese	320	40.2

^a Region was divided into Coast, which includes all municipalities around the perimeters of the island in the north, northwest, northeast, east, southeast, southwest, and west, not including the metropolitan area; Metropolitan region, which includes the metro area including San Juan, the capital of PR; and Central mountain region, which includes the mountainous center of PR.

^b Children were classified into these two categories based on measured BMI and the CDC growth charts.

Table 2

Mean intake of daily total energy, nutrients and food groups as determined by a single 24-hour dietary recall of 12-year-old Puerto Rican children enrolled in the academic year 2010-2011 (n=796).

	Mean (standard error)
Energy and nutrients	
Energy (kcal/d)	1,633 (21)
Protein (g)	59.4 (1.0)
Carbohydrate (g)	212.3 (3.0)
Dietary fiber (g)	8.5 (0.2)
Total Fat (g)	61.7 (1.0)
Saturated fat (g)	21.9 (0.4)
Sodium (g)	2.6 (0.0)
Food groups (servings) ^a	
Refined grains	4.6 (0.1)
Whole grains	0.4 (0.0)
Fruits	1.2 (0.1)
Vegetables	1.2 (0.0)
Meats, poultry, fish and eggs	4.7 (0.1)
Dairy products	1.4 (0.0)
Oils	2.4 (0.1)
Sweetened beverages	2.7 (0.1)

^a Serving size of each group is as follows: Grains = ½ cup if cooked, 1 slice of bread, 1 oz for crackers/ready-to-eat cereal; fruits = ½ cup if fresh/frozen/cooked/canned, ¼ cup if dried or 4 fluid oz if 100% fruit juice; vegetables (includes dark-green and orange vegetables and legumes) = ½ cup if raw/cooked/canned/frozen; meats and others = 1oz if cooked meats, 1 egg, 1 tablespoon if peanut butter or ½ oz for nuts/seeds; Dairy = 1 cup if milk/yogurt, 2 oz if cheese; oils = 1 teaspoon if oil/margarine-butter/shortening, 15 grams if mayonnaise; sweetened beverages (includes sweetened fruit drink, soft drinks, tea and energy drinks) = 8 fluid oz.

Table 3
Mean and standard error of Healthy Eating Index–2005 scores for 12-year-old Puerto Rican children enrolled in the academic year 2010–2011 by social determinants and weight status (n=796).

Variables	HEI Component <i>a</i>												Total HEI-2005 (100 pts)
	Total fruit (5 pts)	Whole fruit (5 pts)	Total vegetables (5 pts)	Dark-green & orange vegetables & legumes (5 pts)	Total grains (5 pts)	Whole grains (5 pts)	Milk (10 pts)	Meat and beans (10 pts) <i>b</i>	Oils (10 pts)	Saturated fat (10 pts)	Sodium (10 pts)	Calories from SoFAAS ^c (20 pts)	
← mean (standard error) →													
All	2.5 (0.03)	1.1 (0.01)	1.7 (0.02)	1.1 (0.01)	4.7 (0.87)	0.8 (0.03)	6.9 (0.04)	10.0 (–)	1.3 (0.65)	4.7 (0.38)	3.3 (0.04)	2.9 (0.58)	40.9 (0.90)
Gender ^d													
Male	2.5 (0.05)	1.0 (0.02) <i>f</i>	1.6 (0.03) <i>f</i>	1.1 (0.01)	4.9 (0.13) <i>f</i>	0.7 (0.04) <i>f</i>	7.1 (0.07) <i>f</i>	10.0 (–)	1.3 (0.09)	4.6 (0.60)	3.1 (0.06) <i>f</i>	2.9 (0.79)	40.8 (0.94)
Female	2.4 (0.04)	1.3 (0.01) <i>f</i>	1.8 (0.03) <i>f</i>	1.1 (0.01)	4.5 (0.11) <i>f</i>	0.9 (0.04) <i>f</i>	6.7 (0.05) <i>f</i>	10.0 (–)	1.3 (0.09)	4.7 (0.49)	3.5 (0.05) <i>f</i>	2.8 (0.85)	41.0 (0.87)
School type ^d													
Private	2.3 (0.07) <i>f</i>	0.9 (0.01) <i>f</i>	1.7 (0.05)	0.8 (0.01) <i>f</i>	4.5 (0.19)	1.0 (0.06) <i>f</i>	7.6 (0.13) <i>f</i>	10.0 (–)	1.2 (0.15)	3.8 (0.88)	3.8 (0.08) <i>f</i>	3.8 (1.27)	41.3 (0.90)
Public	2.5 (0.04) <i>f</i>	1.1 (0.01) <i>f</i>	1.7 (0.02)	1.2 (0.01) <i>f</i>	4.8 (0.10)	0.7 (0.03) <i>f</i>	6.7 (0.04) <i>f</i>	10.0 (–)	1.3 (0.07)	4.9 (0.42)	3.1 (0.05) <i>f</i>	2.6 (0.66)	40.6 (0.91)
Region ^e													
Coast	2.3 (0.05) <i>f</i>	0.9 (0.02) <i>f,g</i>	1.8 (0.03) <i>f</i>	1.2 (0.01) <i>f,g</i>	4.7 (0.13)	0.7 (0.03) <i>f</i>	7.0 (0.06) <i>f</i>	10.0 (–)	1.2 (0.09)	4.6 (0.55)	3.3 (0.06)	2.8 (1.01)	40.5 (0.92)
Metropolitan	2.7 (0.06) <i>f,g</i>	1.1 (0.02) <i>f,h</i>	1.6 (0.03) <i>f</i>	1.0 (0.01) <i>f,h</i>	4.6 (0.13)	0.9 (0.05) <i>f</i>	7.0 (0.07) <i>g</i>	10.0 (–)	1.2 (0.10)	4.7 (0.61)	3.3 (0.06)	2.9 (0.70)	41.0 (0.90)
Central Mountain	2.4 (0.09) <i>g</i>	1.9 (0.04) <i>g,h</i>	1.7 (0.60)	1.4 (0.33) <i>g,h</i>	5.0 (0.31)	0.7 (0.07)	6.0 (0.11) <i>f,g</i>	10.0 (–)	1.4 (0.20)	5.0 (0.99)	3.0 (0.12)	2.9 (1.80)	41.5 (0.88)
Weight status ^d													
Non-overweight	2.6 (0.05) <i>f</i>	1.1 (0.01)	1.6 (0.02) <i>f</i>	1.1 (0.01)	4.8 (0.11)	0.8 (0.72)	6.6 (0.06) <i>f</i>	10.0 (–)	1.3 (0.65)	4.7 (0.37)	3.4 (0.05) <i>f</i>	3.0 (0.70)	40.9 (0.89)
Overweight	2.4 (0.05) <i>f</i>	1.1 (0.01)	1.8 (0.03) <i>f</i>	1.1 (0.01)	4.6 (0.14)	0.9 (0.04)	7.4 (0.07) <i>f</i>	10.0 (–)	1.4 (0.10)	4.5 (0.59)	3.1 (0.06) <i>f</i>	2.7 (1.01)	40.9 (0.92)

^aThe maximum score for each component is specified inside the parenthesis.

^bSignificant testing was not conducted for meats and beans because the maximum score was reached for this component by all subgroups.

^cCalories from SoFAAS= Calories from solid fats, alcoholic beverages, and added sugars.

^dDifferences between the two categories were assessed by *t* tests.

^eDifferences between the three categories were assessed by one-way ANOVA with Bonferroni post hoc test.

^f Means with the same superscript are statistically different at $P \leq 0.05$.
^g Means with the same superscript are statistically different at $P \leq 0.05$.
^h Means with the same superscript are statistically different at $P \leq 0.05$.